ECOLOGICAL CHARACTERIZATION

Recommendations of a Science Review Panel

Workshop held March 9-10, 1995, at the National Center for Atmospheric Research (NCAR), in Boulder, Colorado

Sponsored by:
NOAA Coastal Services Center (CSC),

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and:
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United States Department of Commerce
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ABSTRACT

A NOAA Science Review Panel of seventeen scientists and coastal experts was convened during a one and one-half day workshop in Boulder, Colorado to examine the status and future of ecological characterization and its potential application to the mission of a recently formed NOAA "Center for Coastal Ecosystems Health" (subsequently renamed as the "Coastal Services Center"). The workshop proceeded from background presentations to open panel discussion and a synthesis of recommendations. Initial discussion was framed by questions about the current and future value of ecological characterizations, and how they may be improved, in particular through digital publication. It was generally agreed that ecological characterizations are useful but not widely used, due in part to limitations of their form; whereas digital publication may offer solutions to some of these problems. The panel endorsed the idea of modernizing ecological characterizations by employing digital publication means along the lines proposed. The panel also recognized the need to improve the process of conducting ecological characterizations as well as their content. Discussion focused on defining ecological characterization as a process with greater emphasis on human dimensions, resource valuation, and "what-if" scenarios. The proposed prototype effort was cautiously supported, given the recommendations on improving form, content, and process.

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FOREWORD

In the last two decades important changes have occurred in science and cultural awareness regarding the critical role and broad scale of human influence on ecosystems. Correspondingly dramatic changes have taken place in academic, government, non-government and international scientific programs. These are symbolized by increasingly interdisciplinary programs, and by emerging fields such as landscape and systems ecology, adaptive management, and integrated assessment. These changes indicate a shift toward broader system-level thinking, and integrated studies. In management fields, a shift has also taken place from single-resource management toward landscape and ecosystem-based management. Adaptive management approaches have gained wider acceptance as a means for linking science and management practice through time. Gradually these changes in thinking are also being reflected in public planning and policy making.

In this same time period revolutionary changes have also occurred in information sciences and technologies, as exemplified by the World Wide Web and associated developments. Methods for integrating data and information have improved greatly as part of an underlying digital revolution. Geographic Information Systems (GIS), for example, have improved steadily and their applications have broadened greatly. Their integration with modeling is particularly significant. These events, when combined, suggest fundamentally improved opportunities to synthesize and communicate natural resource and associated management information.

Against such a backdrop of change, it is worthwhile to examine prevailing practices and to assess their potential within the context of newer technology and evolving needs. While the changes leading us into the next century may be rapid and profound, they are also poorly integrated. Emphasis has been placed on modeling, monitoring, and communication but the methods and procedures to link these lag behind. Priority in science funding favors the new and theoretical, sometimes at great expense to the familiar and practical. While increasing amounts of data are being collected about the Earth, only a small percentage can currently be analyzed in a meaningful way. Meanwhile, policy and decision-making continue to be influenced by traditions that are slow to change. The ability to translate a rapidly expanding body of data and scientific information for management purposes is clearly one of the weakest links in these information streams.

This Science Review Panel examined an approach to information synthesis – ecological characterization – that was intended to help bridge the gap between scientific knowledge and management practice. This approach was conceived prior to the "digital revolution" and so employed traditional methods for capturing and communicating results. Nevertheless, it represented something new – recognition of the need for data and information synthesis for management purposes, regarding key environmental,

ecological, and societal issues. While this need was originally acknowledged in the context of petroleum development, and highlighted by growing environmental concerns in the U.S., it is clearly evident today for other issues and in many locations at local to global scales.

With these trends in mind, the workshop organizers sought answers to basic questions about ecological characterization as a method and specific questions about current needs and opportunities for it's implementation. While the impetus for this workshop was the formation of a national coastal science center and the desire to build into it new and forward looking capabilities, re-examining the value and use of ecological characterization was thought to be potentially important for many applications. The opportunity to convene a series of workshops on this topic and its application to the new NOAA center allowed involvement with two important audiences: The first was a sample of the scientific community with intimate knowledge of the benefits and failings of such an approach (accomplished by the workshop reported here). The second was an assembly of coastal managers and program managers representing practical knowledge of characterization requirements and feasibility. The second workshop was held at Seabrook Island, South Carolina (reported separately), directly following the science review workshop. Following these workshops a prototype, the "Otter Island Ecological Characterization," was produced for review by coastal managers. It is our hope that, with the benefit of these recommendations and reviews, a method of synthesis can be defined that can be applied to a rapidly expanding set of ecological issues.

Background of Ecological Characterization

The term ecological characterization was adopted in the 1970's by the U.S. Fish and Wildlife Service Coastal Ecosystems Group (and collaborators) to describe their rigorous efforts at integrating information useful for administering marine oil and gas leases in the Outer Continental Shelf (OCS) and in planning for associated nearshore and onshore impacts. The practice of ecological characterization met increasing needs for environmental and ecological synthesis to support management and planning activities. Although its origins were in marine minerals management with contributions from other fields, the concepts and methods of ecological characterization can be generalized to other coastal and resource management issues.

Ecological characterizations of coastal systems have been conducted as intensive descriptions of ecosystems since their inception and have been published for limited distribution as printed documents. One of the original definitions of Ecological Characterization from the U.S. Fish and Wildlife Service, Biological Services Program was:

> "a study to obtain and synthesize available environmental data and to provide an analysis of the functional relationships between the different components of an ecosystem and the dynamics of that system ... It is simply a structured approach to combining information from physical, chemical, biological, and socioeconomic sciences into an understandable description of an ecosystem."

The literature on ecological characterization includes many useful examples treating different systems and management units from rivers, bays, and estuaries to watersheds and landscapes. Each uses slightly different approaches and methods but all share an emphasis on understanding systems rather than their separate parts and for decision making that is informed by the best possible synthesis. Although they sometimes used computerized systems for data preparation and analysis, early ecological characterizations were (of necessity) published and delivered as paper documents representing the combined synthesis efforts of many scientists and managers.

Terms used in this report:

The orientation session at the start of the workshop presented the concept of "adaptive ecological characterization" as a means to emphasize the advantages of employing new digital production and publication approaches and the subsequent potential for greater user feedback or involvement over time. Further discussion in the workshop emphasized the importance of human dimensions, and entertained the phrase "socio-ecological characterization." Both of these concepts should be considered implicit in the simpler term "ecological characterization," and may be used interchangeably in different contexts. There was agreement that the term "ecological characterization," although intended to be interdisciplinary, is often thought to under-represent societal aspects including the need for community involvement; however, there was no consensus on a better term.

The term "community" came up many times and in many contexts, both in reference to its biological and ecological definition, and in the human sense, to describe groups such as: users of the Center's products and services, "stakeholders," managers, scientists, local residents, the general public, administrators, politicians, educators, students, and data providers. Such communities can be identified at many different scales, from local to global. In this report, the term must therefore be defined by its context.

LIST OF PARTICIPANTS

Following is a complete list of the twenty-four workshop participants, including the organizers and seventeen scientists and experts selected for the Science Review Panel. Names are followed by title(s), affiliation, and primary role(s) or expertise.

(1) Workshop Organizers (by affiliation):

NOAA Coastal Services Center:

Ms. Anne Hale Miglarese, Associate Director for Coastal Information Services, Coastal Services Center (CSC), Charleston, SC (workshop sponsor, in absentia)

Ms. Jennifer Steele, Coastal Services Center, Charleston, SC (CSC representative)

South Carolina Department of Natural Resources:

Dr. Fred Holland, Director, Marine Research Institute, South Carolina Department of Natural Resources, Charleston, SC (SCDNR representative, rapporteur to second workshop, also panel member - see below)

NOAA National Geophysical Data Center:

Mr. David M. Clark, Assistant to the Director, National Geophysical Data Center, Boulder, CO (NGDC representative)

Mr. Allen M. Hittelman, Acting Chief, Solid Earth Geophysics Division (SEGD), National Geophysical Data Center, Boulder, CO (SEGD representative)

Mr. John J. Kineman, Head, Ecosystems Program Area, National Geophysical Data Center, Boulder, CO. (workshop convener and acting component leader for implementation of the Analysis and Characterization Component for CSC)

University of Colorado Cooperative Institute for Research in Environmental Science (a NOAA Cooperative Institute):

Dr. Bradley O. Parks, Environmental Scientist, Cooperative Center for Research in the Environmental Sciences (CIRES), University of Colorado, Boulder, CO (workshop co-convener, facilitator, and rapporteur)

Dr. David Nyquist, Physical Ecologist, Cooperative Center for Research in the Environmental Sciences (CIRES), University of Colorado, Boulder, CO. (Advisor)

(2) Panel Members (in alphabetical order):

Dr. John Clark, Senior Associate, RSMAS. University of Miami, School of Marine and Atmospheric Sciences, Miami, FL (US and international coastal management)

Dr. Andre Clewell, President, Society for Ecological Restoration. A.F. Clewell, Inc., Quincy, FL (ecological restoration)

Dr. Faye Duchin, Vice President, Society for Ecological Economics; Director, Institute for Economic Analysis (IEA), New York University, New York, NY (ecological and environmental economics)

Dr. Michael Glantz, Director, Environmental and Societal Impacts Group (ESIG), National Center for Atmospheric Research (NCAR), Boulder, CO (environmental impacts and society)

Dr. James Gosselink, Professor Emeritus, Louisiana State University, Coastal Ecology Institute, Baton Rouge, LA (coastal and landscape ecology and ecological characterization; advisor to South Carolina DNR for Edisto River Basin Ecological Characterization)

Dr. Lance Gunderson, University of Florida, Arthur R. Marshall Laboratory in Ecological Sciences, Gainsville, FL (coastal ecology, adaptive management)

Dr. Fred Holland, Director, Marine Research Institute, South Carolina Department of Natural Resources, Charleston, SC (coastal and marine research; DNR representative)

Mr. William Marshall, Coordinator of Planning and Research, South Carolina Department of Natural Resources, Water Resources Division, Charleston, SC (Director, Edisto River Basin Ecological Characterization)

Dr. William Michener, Associate Scientist, Jones Ecological Research Center, Newton, GA (environmental data analysis and landscape ecology)

Dr. Kent Mountford, Senior Scientist, Chesapeake Bay Program, US EPA Chesapeake Bay Program Office, Annapolis, MD (Chesapeake Bay Program and characterization practices)

Dr. Bryan Norton, Professor of Philosophy of Science and Technology, Georgia Institute of Technology, School of Public Policy, Atlanta, GA (ecosystem valuation and management)

Dr. Howard Odum, Professor and Graduate Research Scientist, University of Florida, Environmental Engineering Sciences, Gainsville, FL (systems ecology, energetics, and valuation modeling)

Dr. Edward Pendleton, Chief, Aquatic Ecology Laboratory, National Biological Service, Kearneysville, WV (aquatic ecology and ecological profiling)

Dr. John Petterson, President, Impact Assessment, Inc., La Jolla, CA (social impact assessment)

Dr. Jay Watson, Representative to the Regional Ecosystems Office for the President's Forest Plan, US Fish and Wildlife Service, Regional Ecosystem Office, Portland, OR (coastal ecological characterization and ecosystem management - Northwest US)

(3) Panel Members in Absentia

Dr. John Cairns, Professor of Environmental Biology, Center for Environmental and Hazardous Materials Studies, Virginia Tech., Blacksburg, VA (ecosystem restoration)

Dr. Robert Costanza, President, Society for Ecological Economics. University of Maryland, Center for Environmental and Estuarine Studies, Solomons, MD (coastal ecosystems modeling)

Special Acknowledgments

This workshop would not have been possible without the support of Anne Hale-Miglarese and funding provided by the Coastal Services Center. Special appreciation also goes to Dr. Bradley Parks for engaging the participation of panel scientists and writing the discussion portion of this document. The able support of the University Consortium for Atmospheric Research (UCAR) conference services staff is also gratefully acknowledged.

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EXECUTIVE SUMMARY

This Science Review Panel consisting of fifteen scientists and coastal management experts was convened to evaluate the status and value of ecological characterization, to provide guidance for starting (through prototype efforts) an analysis and characterization function at the formative Center for Coastal Ecosystems Health (since renamed to the Coastal Services Center – CSC), and to communicate recommendations of this panel to appropriate communities. Ecological Characterization can be described generally as a comprehensive but focused summary of the physical, ecological, and human systems of an area, including management options. Initial discussion was framed by several fundamental questions:

1. Are ecological characterizations valuable? Adaptable? Useful for coastal management? Helpful in understanding ecosystem health?
2. Can they be significantly improved from their printed form by using digital synthesis (for example, using methods associated with Geographic Information Systems) and digital publication methods?
3. Does ecological characterization have an important role in the future, and if so, how should it be improved (content and method) and what are the cautions?
4. Should a modern digital prototype be produced to test new approaches?

The value of the ecological characterizations was confirmed, while significant limitations were noted in their past implementation and their physical form. Some of these limitations may be addressed by employing digital methods and techniques that can provide: interactivity with users; much needed review and update capability; cheaper and easier distribution; multiple uses of a single product; more effective communication through multi-media; and greater involvement of both management and scientific communities. Scientists on the panel endorsed the idea of modernizing ecological characterizations by employing digital publication means along the lines proposed.

Digital capture of existing characterizations was, of itself, not considered sufficiently valuable, in part because of limitations already built into past documents. Instead, it was recommended that a process for ecological characterizations be developed and formalized, which includes digital publication but addresses new requirements for content and use as well as the need to involve a broader sector of the user community. A participatory process beginning at the local level was recommended. The incorporation of socio-economic and other human dimensions was emphasized, as was the need for better resource valuation methods and the importance of assessing user needs at the outset. The panel endorsed the proposal to prototype new methods by constructing an ecological characterization for a site in the Edisto River Basin.

In addition, panel discussions explored a wide range of questions related to potential improvements in the practice (or process) of ecological characterization. Following are highlights from those discussion sessions. More detailed summaries are provided in the body of this report.

A. Use and value of ecological characterization

- Ecological characterizations can provide needed information for making coastal environmental decisions and should be improved for this purpose.
- Doing better characterizations should begin by addressing their limitations, which include that they are: not problem-specific; not easily or widely accessible; "snap shots," not "living documents;" under-representative of human dimensions; and static representations of dynamic processes.

B. Ecological characterization as a process (for dynamic, socio-economic, ecosystem management)

- Consider whether appropriate questions are being asked before considering whether specific responses or work products are useful for and suitable to the goal of "working people through" a system designed to help them control their environment. If so, rely on all of the parties involved, coherent and accepted process steps, and common tools.
- Since characterization may be an involved process that may take years to complete, sustained effort is needed throughout its life-cycle -- one that is experimental, captures dynamic change, and supports learning.
- Valuation and characterization should precede decisions about ecosystem management, and may help inform analysis, modeling, and monitoring.
- Ecological characterization should provide a values-articulation process which strengthens local sense-of-place values in an ecological context and helps people to act consistently with them. The result should be a high ratio of opportunities-to-constraints which may require conflict resolution and an inter-generational dialog.
- Valuation and characterization cannot rely only on natural sciences dimensions; they must incorporate the social sciences and socioeconomic dimensions for which adequate methods and techniques do already exist and should be used.
- Additional prototype work should proceed in areas having dense human populations, to test a fuller range of methods and applications, and to demonstrate how human dimensions should be handled.
- There was no agreement about how to define or evaluate ecosystem health or whether it is an inherent property of ecosystems or one determined by interaction of humans with their environments. Regardless, the ecological characterization process should be inclusive of both ecological and socioeconomic dimensions.

C. Framework for implementing ecological characterization

- Joint action by communities and experts to discover and articulate values culminating in community visions of options or choices should determine how to integrate and use the varied information in a characterization, but we lack: (1) a unified values system (to make values and options comparable) and (2) a universal model for the valuation process (to guide communities to decisions consistent with values).
- To refine the process suggested here, we should begin with and emphasize uncertainties, not avoid the complexity of ecosystems and attendant problems (these lie at the heart of the problems that ecological characterization should help to resolve), avoid the temptation to think of characterization in a purely objective/descriptive (objectively determined rather than valuative) sense, and explore methods of performing values inventories.
- There should be continuing effort to identify customers and genuine needs, to exploit existing public participation methods and models, and to adapt the science review panel recommendations to "local" (especially extreme) expectations.
- The Edisto River Basin area is a reasonable place to begin to develop the capacity to work in microcosm along the lines recommended here, particularly expanding into the domain of community values.
- The utility of ecological characterizations should be broadened by addressing the over-arching theme of ecosystem integrity. Begin by focusing on: management options and choices rather than singular solutions; developing community vision (from community values); and planning for consistent management.
- Ecological characterization should support and directly involve designated resource managers as well as other interested persons but its first priority should not be the servicing of enforcement functions.
- Digital data publications for delivery of ecological characterizations in compact disk format would be a useful improvement particularly if they:
  - Include descriptive elements dealing with past, present, and future (scenarios);
  - Include socioeconomic dimensions;
  - Present inputs, outputs, and other system properties in a manner that depicts dynamic change;
  - Use appropriate temporal scales and future thresholds or milestones to foster understanding of a system's time continuum and the human role in it;
  - Use appropriate or multiple-scale (spatial) schemes – recognizing that there are problems of linking scales in such a multi-scale approach.
- Ecological characterization should include the capability to track progress toward achieving management goals and means of showing interactions of sources or causes with responses of systems and their management regimes.
- Avoid reliance of any single technological approach or technique. Explore the strengths and complementarity of different techniques and approaches (such as GIS,

Emergy analysis (see Appendix D), modeling, and game-like simulations) and undertake characterizations in different ecosystem types to develop comparative understanding and versatility.

- Choices of specific tools, techniques, and software become system and situation-specific and are therefore the natural domain of those carrying out and publishing an ecological characterization and those who will use such work products.
- Appraisal should be made, a priori, of the decision maker's tolerance for uncertainty about data, understanding of relationships they may reveal, and inferences drawn from their use.

INTRODUCTION

Purpose

This report documents the transactions and recommendations of a NOAA Science Review Panel that examined the state and future of ecological characterization and its potential application to the mission of the recently formed NOAA "Center for Coastal Ecosystems Health," subsequently renamed the "Coastal Services Center" (CSC).

The goal of the workshop was to evaluate the scientific basis and future opportunities for (adaptive) ecological characterization and to provide guidance to NOAA and the scientific community. Immediate objectives were to provide scientific guidance for developing Analysis and Characterization core capabilities at the newly formed NOAA center; and to provide specific guidance to a subsequent workshop concerned with implementing these capabilities in a proposed prototype ecological characterization on compact disk.

Desired outcomes were:

1. recommendations for NOAA and the scientific community
2. guidance for future projects and programs
3. input to the next workshop, to be held at Seabrook Island, SC, March 15-16, 1995

Workshop Organization

The workshop was convened by the National Geophysical Data Center (NGDC) and the University of Colorado - NOAA Cooperative Institute for Research in the Environmental Sciences (CIRES) in collaboration with the Coastal Services Center (CSC), and was held at the National Center for Atmospheric Research (NCAR) in Boulder, Colorado, March 9-10, 1995.

The workshop convened a Science Review Panel of fifteen prominent scientists and experts (see list of participants). Candidate panel members were identified through recommendations by colleagues and professional and scientific groups. Members were recruited to the review panel with attention to professional standing, subject matter authority, group balance within and among disciplines, and geographic and institutional representation. Selections were subsequently confirmed with peers. The workshop relied on free information exchange among the panelists followed by facilitated discussion and group synthesis of results.

The Agenda

The Science Review Panel work period was one and one-half days (March 9 and 10, 1995) and was divided evenly into three sessions. The workshop began with a charge to panelists, including concepts of ecological characterization envisioned for implementation at the new center. The first session also included a presentation on the Coastal Service Center's structure and programs. This orientation was then followed by two cases to define ecological characterization by example: (1) the earliest extensive effort led by the Fish and Wildlife Service (FWS) in the 70's and 80's which characterized much of the US coast, and (2) the Edisto River Basin study, a contemporary ecological characterization which built on earlier FWS experience but modernized the approach and methods. This session concluded with a presentation of plans at CSC for implementing an ecological characterization prototype effort focusing on the Edisto River Basin.

The second session, which completed the first day, was devoted to open discussion and served the purpose of unfolding many of the initial assumptions and relevant issues bearing on the desired outcomes listed above. The third session consisted of a half day of structured discussion which imposed a useful organizing framework, and synthesized previous recommendations and comments for final preparation in this report. The discussion then moved to identifying points of consensus, recommendations, and questions for further development regarding the approach and its proposed implementation at CSC.

Examples of relevant digital products and prior ecological characterization documents were on display throughout the workshop to help stimulate questions. Workshop conveners acted as facilitators with assistance from CSC staff and Science Review Panel members. Some follow-up interviews were conducted to help complete this document, an early draft of which has been reviewed and commented upon by those who participated. Several position statements or extended commentaries prepared by panelists during the workshop or before release of this report are included as appendices.

The Charge to the Panel

The panel was asked to answer fundamental questions about the status and future of ecological characterization, and to review plans that were presented. Steps for developing the Analysis and Characterization component (of CCEH) were outlined as follows:

(1) Develop initial plans: (a) to establish Ecological Characterization applications and outreach capabilities, (b) to demonstrate both concept and capability in a prototype, and (c) to link the technical components with the larger community of Geographic Information System (GIS) users and developers.

(2) Obtain program guidance from this and a subsequent "design" workshop, modifying plans accordingly.
(3) Begin developing ecological characterization products for key areas, beginning with a reviewed prototype based on a suitable case study and employing the recommendations of the panel.
(4) Integrate analysis and characterization activities with other parts of the information system [at CSC].
(5) Link these efforts to resource managers and other communities of users through the Center's management outreach functions.
(6) Ensure long-term links with research and GIS developers.

In this process, it was assumed that other elements at [CSC] would be responsible for identifying specific community needs and priorities (to drive ecological characterization efforts), as well as necessary training and outreach (to connect it with effective management).

A "strawman" concept for the prototype was presented using a "digital publication" model with specifically defined contents that parallel accepted standards for literature publication. This proposed focus suggested an expansion of the original definition of ecological characterization products (see appendix A). Retaining the three major elements of the original definitions and adding a fourth, ecological characterizations were proposed that are:
(1) Goal-directed (aimed at management goals)
(2) Model "driven" (ecosystem structure and function, including human dimensions)
(3) Synthesis oriented (scenarios supported by current knowledge)
(4) Supported by integrated databases (interactive GIS approach)

An important part of the above concept, presented as "adaptive ecological characterization" (AEC) would involve the combination of traditional ecological characterization methods with Geographic Information Systems (GIS), recognizing an unpredictable number of uncertainties (σ^n), for example those introduced by human dimensions and the adequacy of existing information. This was symbolized by the equation: $EC + GIS + \sigma^n = AEC$. In this view ecological characterization products would become interactive tools supporting a set of questions that help explore specific management options (asking "what-if"), but necessarily constrained by available knowledge [and other human factors].

The overall process (of which ecological characterizations would be an output of the data and information activity), would be widely accessible (involvement of multiple communities) and embodied in a common methodology, with strong feedback mechanisms.

An example of the contents and media of such a product was presented as:
(1) An ecological characterization report

(2) Methods and guidelines for ecological characterization
(3) A study area database
(4) Management scenarios (alternate uses and options)
(5) Model outputs and/or embedded models
(6) A GIS analytical interface
(7) A hypertext interface

The final charge to the Science Advisory Panel was presented in the form of a series of questions. These are summarized as:

1. Are ecological characterizations valuable? Adaptable? Useful for coastal management? Helpful in understanding ecosystem health?
2. Can they be significantly improved from their printed form by using digital synthesis techniques (for example, using methods associated with Geographic Information Systems) and digital publication methods?
3. Does ecological characterization have an important role in the future, and if so, how should it be improved (content and method) and what are the cautions?
4. Should a modern digital prototype be produced to test new approaches?

Issues proposed to be addressed with greater emphasis by the second (design) workshop were:
(1) Specific user requirements
(2) Focus area for the case study (prototype)
(3) Prototype design
(4) Technical options
(5) Delivery mechanism

OBSERVATIONS AND RECOMMENDATIONS

INITIAL OBSERVATIONS

- Definitions of ecological characterization vary most in the extent to which they address either (a) the process of conducting ecological characterizations, or (b) their results (the product). Aside from that basic difference, definitions also vary in detail depending on circumstances and goal.
- As a basic concept, it was clear that ecological characterizations are intended to be focused syntheses (or synthesis efforts) incorporating multi- and interdisciplinary perspectives, based on readily obtainable knowledge, and intended for management use (see definitions in Foreword and Appendix A)
- Ecological characterizations of the past generally fulfilled their intended function and are still considered useful, however they are not widely used due to irreversible limitations that are traceable in part to their form, and in part to their content.
- Future ecological characterizations can provide the needed information for making coastal environmental decisions, but should be modernized with respect to form, content, and use.
- Digital publication methods, along the lines proposed to the panel, offer the potential to resolve many of the limitations resulting from form and media (content questions are a separate matter, although affected by improved feedback). This potential includes:
  - increased interaction and feedback
  - improved review and update capability
  - wider distribution at multiple skill levels
  - multiple uses
  - interactive information retrieval and analysis capabilities
  - more effective communication through multi-media
  - greater involvement from both management and scientific communities
- Technical limitations also exist in the suggested digital approach. These include: platform and software dependence, the lack of interoperability among available software, and the prevalence of compatible equipment among the intended users.
- The panel cautiously endorsed (with two exceptions, see Appendix E) the proposal to produce a modern digital prototype through the Coastal Services Center.

PANEL DISCUSSIONS

The following are comments and recommendations taken directly from key points discussed by panelists in the general discussion sessions. Not all recommendations represent unanimous decisions or full consensus due to time limitations. Key suggestions not rejected or countered in panel discussions are included. Similar comments have been collapsed to minimize redundancy. All comments have been reorganized to simplify their presentation and to merge them with the three-part outline proposed by panelists late in the workshop (sections A, B, and C below). Within that outline items are presented in logical succession, each building on its antecedents. These recommendations are explained more fully in the discussion section that follows this section.

As noted earlier, since there was not agreement about a different term for an expanded approach to characterization, the customary term of ecological characterization has been used here. However, all references to ecological characterization as a future activity imply the incorporation of socioeconomic dimensions.

A. Use and value of ecological characterization

Given that ecological characterization can provide information useful in making coastal environmental decisions (see assumptions above), doing better characterizations may begin by addressing their limitations, which include that they are:

- not problem-specific – balance (or better, synergism) is needed between a broad-based information framework and situation-specific information products.
- not easily or widely accessible – users should be freed (by appropriate computer tools and media) from past constraints on their ability to locate, access, evaluate, and extract information relevant to their needs.
- "snap shots", not "living documents" - past characterizations were one-time efforts in printed form without a programmatic means for updates. Once out-dated, they can not be readily or selectively changed.
- under-representative of human dimensions - they tend to deal last or least aggressively with more controversial or intractable issues and to oversimplify or exclude alternate valuation schemes that should inform visions of "sustainable" human uses.
- static representations of dynamic processes - most existing ecological characterizations:
  - define narrowly the range of information they will or can provide
  - encourage predefined use more as end products than as means to other management ends,
  - do not provide interactive capabilities that can help users to learn by asking (exploring) "what-if" questions and to generalize information to other situations,

- tend to represent inherently "changeable" processes as unchanging ones, and
- do not re-introduce management choices as feedback to the behavior or condition of a managed system.

B. Ecological characterization as a process (for dynamic, socio-economic, ecosystem management)

Needed improvements in the practice or process of ecological characterization, reflected in the above title, are discussed in specific observations and recommendations listed below.

General comments

- The first step is to consider whether appropriate questions are being asked before considering whether specific responses or work products are suitable to address such questions.
- The primary work product should be a process to "work people through" a system designed to help them control their environment (in a manner consistent with community resource valuation and sustainability goals).
- Characterization efforts should rely on all of the parties involved (stakeholders), coherent and accepted process steps, and common (shared) tools.
- A "products-first" orientation to priority setting should be informed and balanced by a sense of the use of such products and it redoubles the need for division of labor and active collaboration.

Description of the process

- Practitioners are reminded that if done properly, characterization may be an involved process taking years to complete.
- Commitment and effort should be sustained throughout the life-cycle for characterizations, recognizing their potentially long time-to-completion, and their proper role as part of a longer-term management process.
- CSC should exploit its opportunity to provide leadership in ecological characterization by supporting alternate management approaches and technologies.
- To be useful, and perhaps enduring, characterization efforts should reflect dynamics of change (to the extent that they are known and understood).
- Effective characterization should sustain learning by:
  - presenting an understanding of ecosystems
  - mapping visions for the future

- cultivating a sense-of-place, and
- focusing on direct participation and interaction with the environment

Value articulation and development

Valuation can be defined, for working purposes, as: "the process of helping 'communities' of people to discover and understand their different and potentially conflicting values concerning natural resources and ecosystems, including socioeconomic structures and processes. This may include harmonizing those values and acting consistently with them."

- Valuation and characterization should precede decisions about ecosystem management, and may help inform analysis, modeling, and monitoring.
- Conflict resolution is not equivalent to, but is implicit within ecosystem valuation.
- Ecological characterization should help strengthen local sense-of-place values in an ecological context using models, schemes, and tools to find harmonious relationships between humans and natural communities.
- The long-range purpose of ecological characterization should be to help people develop such values (above) and act consistently with them.
- The goal of values articulation processes should be to maintain a high opportunity-to-constraints ratio.
- In assessing this ratio of opportunities-to-constraints, a multi-dimensional concept of value should be used to accommodate different time frames, rules, and community visions.
- An inter-generational dialog should be included in valuation efforts in order to inform long-range (or multi-generational) considerations.
- Natural and physical science dimensions (of traditional practice) are necessary for valuation and characterization but they are not sufficient.
- Social sciences and socioeconomic dimensions should also be represented in valuation and characterization.
- (Some) adequate methods and techniques for valuation do already exist and should be used to more fully incorporate socioeconomic factors.
- Prototype work such as that proposed to begin in the Edisto River Basin can add important value by demonstrating to others how human dimensions can or should be handled.
- In addition to that planned for less inhabited areas, prototype work should be undertaken in areas having dense human populations in order to better test a fuller range of methods and applications.
- There was no agreement, and is none generally, about how to define or evaluate ecosystem health or whether it is an inherent property of ecosystems.

- One view is that nature imposes some rules (governing conditions) which transcend human decisions (choice) and that understanding these is a matter of (task for) pure (natural) science (referred to below as a natural science model).
- Another view is that values (evaluations) are determined by interaction of humans with their natural environments and that we should avoid reverting to pure natural science [i.e., "self-explanatory" or objectively determined] models (see below).
- In the latter view, the health concept is not "self-explanatory" (objectively obvious), but has a strong evaluative component which should be integrated with the natural science component in a community (participatory) procedure.
- Regardless of viewpoint on valuation, there was agreement that the ecological characterization process should be inclusive of both ecological and socioeconomic dimensions and should be relabeled accordingly.

C. Framework for implementing ecological characterization

Present the process in the form of a procedural model

- Panelists envision a model wherein communities approach experts for assistance with ecological characterization. A joint response would then be made to discover and articulate values culminating in community visions of options or choices and selection among associated trade-offs.
- Missing elements for such a holistic approach to ecosystem management are (1) a unified values system (in reference to options) and (2) a universal model for the valuation process (to guide communities to decisions consistent with values).
- We are reminded that values determine what will be included in a characterization.
- A key question is how best to integrate and use/provide the varied information required for these actions and processes.
- An appropriate next step is to refine the conceptual model suggested in the observations and recommendations of this workshop.
- Such refinement should begin with, and should emphasize uncertainties since it is the subjects about which there is less confidence or consensus (or more contention) that lie at the heart of the problems that ecological characterization should help to resolve.
- Similarly, we should not avoid the complexity of ecosystems and attendant problems but instead try to capture their complexity and rely on other (analytic) means to simplify them sufficiently for understanding.
- In refining the procedural model implied here, a broad values context should be preserved and we should avoid the temptation to think of characterization in a purely objective/descriptive (objectively determined rather than valuative) sense.
- The resulting process should incorporate a values inventory using comparable units but if an objectively based scheme (such as Emergy dollars – see Appendix D) is

used, it will need to be merged with the values dimension to incorporate the element of choice.

Assess user needs

- If a products-first orientation is to be adopted (for purposes of expediency), then there should be continuing effort to identify customers and genuine needs.
- The Edisto River Basin (or some portion thereof) is a reasonable place to begin to develop (prototype) the capacity to work along the lines suggested here (this acknowledges the strong start made in previous Edisto work).
- Additional characterization work in the Edisto River Basin might usefully expand (further) into the domain of community values.
- Future characterization work, particularly that incorporating valuation efforts, should exploit existing public participation methods and models.
- The workshop to be held at Seabrook Island, SC should further address questions clarifying why ecological characterizations (and the suggestions of this Science Advisory Panel) can and should be implemented on a case-specific basis.
- In subsequent workshops, ecosystem managers and regulators should view the recommendations of this panel critically, on a site-specific basis and should adapt them to "local" expectations. We are reminded that extreme expectations warrant serious attention early in the process.

Consider key questions

- The effort to meet assessed needs should be forward-looking and should focus on developing community vision (from community values), and on planning for consistent management – not on consequent actions such as implementation, enforcement, or feedbacks.
- In determining which questions will be answered with the help of ecological characterization, it is critical to focus on options and (multiple) choices, rather than singular solutions.
- The utility of ecological characterizations should be broadened by addressing the over-arching theme of ecosystem integrity and trade-offs that accompany management options and choices.
- It is important to remember that the autonomy of the CSC's Analysis and Characterization (A&C) component is or should become limited. Other components should come to perform complementary functions and should share influence and responsibility in asking and answering questions.

Consider how decisions are made

- Ecological characterization should not have as its first priority, the servicing of enforcement functions.
- Characterization should establish built-in involvement of managers and such participation should be significant and direct.
- Ecological characterization should support not only the constrained needs of designated resource managers but also the broad array of needs among others interested in management generally. This suggests that considerable versatility may be required.

Assess data requirements

General comments

- Subject to user requirements and other case-specific "implementation" considerations, digital data publications for delivery of ecological characterizations in compact disk format would be a useful improvement.

Thematic data

- To better inform the evaluative aspect of characterization, include descriptive elements dealing with both the present and the past.
- Begin adding value to such a descriptive approach (of which the Edisto River Basin Study is a good example) by actively including socioeconomic dimensions.
- Account for inputs to and outputs from the system and present these and other properties of the system in a manner that depicts dynamic change.

Temporal data

- Identify appropriate temporal scales given values and factors to be characterized.

- Use forward-looking thresholds or milestones by which time(s) community preferences might become satisfied. For example, ask "what should a system look or be like in "n" years time?
- Explore the notion of temporal sense-of-place to foster understanding of a system's time continuum and the human role in it.

Spatial data

- Emphasize the importance of getting spatial scale aspects of ecological characterizations "right." Scale(s) choice is critical to the usefulness of such products.
- Use multiple-scale schemes where possible to accommodate frequent need for different, simultaneous data scales.
- Broad (larger) scales are especially important in multi-scale approaches to ecosystem management because they may be more revealing about longer-term, slower-acting changes occurring at the "landscape" (less detail-conscious) level.
- There are problems of linking scales in such a multi-scale approach. These affect our ability to relate in a valid manner, the information contained in data of different scales.

Assess analytical / modeling requirements

In this context, modeling employs numerical simulations and computer algorithms to study processes in nature, but is strongly linked to data analysis in a complementary relationship. As used here modeling refers to mathematical or process models not to cartographical models or other purely procedural expressions. Conceptual models of an ecosystem (see Appendix D for an example) may also apply.

- Methods and techniques of ecological characterization should include the capability to track progress toward achieving management goals.
- Ecological characterization should include means of showing interactions of sources or causes with responses of systems and their management regimes.
- Caution is urged against reliance or over-emphasis of any single technological approach or technique. For example, over-emphasis on use of geographic information systems (GIS) to the diminishment or exclusion of other tools.
- One example of complementarity with GIS technology is Emergy analysis (see Appendix D) which could be used in concert to produce maps of Emergy dollars showing spatial patterns useful in comparing and evaluating available choices.
- Other examples of complementarity with GIS are algorithms (models) which can be used to relate data sets / layers within a GIS.
- We are reminded to rely on models to simplify those systems whose complexity we are encouraged to capture, in order to help make them understandable and manageable.
- We are encouraged to evaluate a gaming approach (among others). Consider for example, an estuarine application modeled after Sim City, City Bio II or others.

Determine tolerable degree(s) of uncertainty

- Appraisal should be made, *a priori*, of decision maker's tolerance for uncertainty about data, understanding of relationships they may reveal, and inferences (or predictions) drawn from their use.

Match answerable questions to collectible data subset(s)

- Characterizations should be undertaken in different ecosystem types for the purpose of developing comparative understanding and versatility among the methods and techniques used.
- If such a comparative approach becomes too resource–intensive, then a focus on limited ranges of management scenarios could be adopted as a compromise.
- Ecological characterizations should include the development of alternative management scenarios for the future.

Identify software, models, and other tools

Identification of specific tools and techniques, software or otherwise, is the point at which discussion and recommendations from this workshop terminated. It is agreed that these choices become system and situation-specific and are therefore the natural domain of those carrying out and publishing an ecological characterization and those who will use such work products. Further discussion of tools and techniques was also the planned point of transition to the second, follow-up workshop (Seabrook Island), focusing more directly on implementations.

DISCUSSION

The discussion of initial observations (below) summarizes the panel's response to presentations and the basic questions posed (see Introduction). This is followed by panel recommendations from the general discussion sessions, organized as in the previous section

Every effort has been made to preserve the intent of the panel members as originally expressed. Some points have been combined to minimize redundancy and all have been reorganized to simplify their presentation. Since discussions of the Coastal Service Center's interests in ecological characterization were pervasive, no attempt has been made to separate recommendations specific to CSC.

INITIAL OBSERVATIONS

Before a useful discussion could begin, there was some need to address the question of how ecological characterization is defined. Definitions (from the presentations and subsequent discussion) varied most in the extent to which they addressed either (a) the process of conducting ecological characterizations, or (b) their results (i.e. the product). Aside from that basic difference, definitions also vary in detail depending on circumstances and goals. As a basic concept, it was clear that ecological characterizations are intended to be focused syntheses (or synthesis efforts) incorporating multi- and interdisciplinary perspectives, based on readily obtainable knowledge, and intended for management use (see definitions in Foreword and Appendix A)

Ecological characterizations of the past have generally fulfilled their intended function and are still considered useful, however they are not widely used due to limitations that are traceable in part to their form, and also in part to their content (see below). Future ecological characterizations can provide the needed information for making coastal environmental decisions, but should be modernized considering form, content, and use.

Although the technical details were not explored in depth, the potential of digital publication methods (along the lines proposed) to resolve many of the limitations due to form was recognized. This potential (as presented to the panel) may include:

- increased interaction and feedback
- improved review and update
- wide distribution at multiple user levels

- multiple uses
- interactive information retrieval and analysis capabilities
- more effective communication through multi-media
- greater involvement from both management and scientific communities

Technical limitations in the digital approach were also noted, such as platform and software dependence, the degree of interoperability among available software, and the prevalence of compatible equipment among the intended users.

Recognizing the value of enhancing and modernizing the product of ecological characterization (i.e., from paper to digital form), so as to improve its function in ecosystem management, the panel cautiously endorsed (with two panel members taking exception – see Appendix E) the proposal to produce a modern digital prototype through the Coastal Services Center, given the recommendations reported here. Greater emphasis was given in the ensuing discussion, however, to ways of improving the content and process of ecological characterization. These discussion sessions are represented below, in the three-part structure recommended by the panel.

PANEL DISCUSSIONS

A. Use and value of ecological characterization (limits and opportunities)

It is agreed that broad scale descriptive ecosystem studies (of watersheds, landscapes, or other units of analysis), typically called ecological characterizations, can provide information useful in making coastal environmental decisions, particularly if augmented to meet contemporary problem-solving needs and to learn from historical examples. It is also agreed that definitions may vary for ecological characterization and its constituent parts but that more important questions include how to perform better characterizations, with what results, and at what costs? It is instructive that ecological characterizations are not generally included in coastal decision making processes, probably because they are:

- **not problem-specific -** While consistent with the original purposes of many such documents – to synthesize and centralize available knowledge and information – this approach may appear ambiguous or over-reaching and can thus give rise to the criticism of "trying to be all things to all people." Balance (or better, synergism) is needed between a broad-based information framework and situation-specific information products.

- **not easily and widely accessible -** There are constraints on their use by the coastal decision making community (such as local land planning agencies, regulatory agencies, etc.) stemming from their limited physical distribution and from the traditional print medium used. A broader group of users should be able to more easily locate, access, evaluate, and extract information relevant to their needs.

- **"snap-shots," not "living documents"** - Most existing characterizations were designed as one-time efforts to capture (coastal) knowledge, status, and trends in a printed form without provision (programmatic or otherwise) for their update. As a result, most characterization documents have become out-dated. And, even if resources were available, most characterizations would be difficult and costly to update since the data and information they contain is not in a (digital) format that can be readily and selectively changed. Future efforts to overcome these limits by revising past characterization documents for general use will risk criticism for not being sufficiently problem-specific.

- **under-representative of human dimensions** - Many characterizations do not contain sufficient information about socioeconomic conditions with which to establish relationships between anthropogenic influences/consequences and ecological conditions. They also tend to deal last or least aggressively with the (seemingly) most controversial or intractable of such issues and to oversimplify or exclude alternate valuation schemes that should inform visions of "sustainable" human uses or management actions. To the extent they share these deficiencies, they do not contain all the information that decision makers need.

- **static representations of dynamic processes** - Existing ecological characterizations define narrowly the range of information provided to help users identify and evaluate future risks or to examine different management options. Their "snap-shot" quality encourages predefining their use more as end products than as means to other management ends. None provides interactive capability allowing users to explore and learn by asking "what-if" questions or to evaluate new or competing management "scenarios". Also, they typically represent inherently "changeable" processes which vary through time and space as unchanging ones *(as they existed prior to or at the time of characterization),* and they do not re-introduce management choices as influences on the behavior or condition of ecosystems (critical feedback, if management is to be sufficiently adaptive).

B. Ecological characterization as a process (for dynamic, socio-economic, ecosystem management)

One observer speculated that good scientific or management "products" from the CSC would likely find their own "market" of appropriate problems and solution users. Most panelists however, felt the opposite to be true; that "markets" would and already do require suitable, specific products, including improved characterization methods. But they warn that these two problem-solving pathways may employ different means to reach their different ends. Panel members were concerned that appropriate ends should be discovered through processes discussed below.

General comments

The first and most important question is not whether proposed characterization efforts are properly designed but whether such proposals are the right response to the right questions. Put simply, we should first ask whether we are doing the right thing (to manage ecosystems) and then ask whether we are doing the thing (characterization) right. The meaning of this is made clearer by the admonition that the primary "product" (capability or service) offered to users should be a process for "working people through" a larger "institutional" system with the purpose of helping them to control their environment. This implies creating a means of helping users to discover and evaluate what they need and want in a context of community values and then cooperating to structure responses that use the CSC's resources and capabilities to help communities achieve their vision of sustainable management for their home ecosystem. To be effective in this form of coastal ecosystem management, the CSC should rely on all parties involved, coherent and accepted processes, and shared tools.

If a products-first orientation is to be adopted (reasonable for an agency which must demonstrate results and impacts) it should be informed by a sense of their use. This sense of purpose can only be gotten by working in a values framework with a broad scope which should include not just natural systems in a traditional, narrowly defined ecology, but also socioeconomic factors as in a broadly–defined ecology. (Landscape ecology is a variant which is founded on such an approach.) A products-first orientation should also rely on effective division of labor and active collaboration among components at the CSC to balance both perspectives and work load.

Description of the process

Another important question is whether characterizations will really be used and if so, for how long? Characterizations are often "front-loaded" by default, if not by design, meaning that they focus resources on the early stage of solution-finding and are short-lived (ephemeral) relative to the problem(s). They are also criticized as "static" rather than dynamic in that they tend not to accommodate or reveal change. Most panelists agreed that characterizations would be more useful if they were part of a long-term, iterative process. The recommended alternative is that the CSC sustain on a long-term basis its effort in areas characterized, that it exploit the accompanying opportunities to try alternate approaches for management or problem solving, and that it use multiple technologies to support those efforts. As a cautionary note in all of this, we are reminded that the temporal scale attaching to characterization for ecosystem management ranges from years to decades.

An important aspect of such sustained effort concerns the ability of a larger process (already described) to sustain learning. Three questions were posed which were considered integral to successful ecosystem management; (1) how do we develop an integrated way of understanding ecosystems? (2) how do we integrate understanding in

order to map out a vision(s) of the future? and (3) how do we develop a system that sustains learning? Two ideas were offered in response: (1) that the notion of site visits be adapted to ground more abstract management dimensions in a sense of a place and its unique attributes, and to provide direct, personal involvement with the environment, and (2) that local involvement in the work of managing, especially restoration, provide people a chance to participate in natural processes.

Value articulation and development

Environmental and resource valuation was a major discussion point at the workshop. Its importance was perceived by panelists to warrant a re-orientation of some CSC activity or emphasis. It is presented here as the cornerstone for the long-term, dynamic, learning-based process in which characterization is embedded and which the CSC should target. Characterization is also discussed at some length under implementation below. Its general purpose and contours are accepted, with the condition that valuation becomes its starting and reference point and that socioeconomic dimensions are fully and actively included.

Valuation is defined here as the process of helping "communities" of people to discover and understand their different and often conflicting values concerning natural resources and ecosystems (including socioeconomic structures and processes), and how to act consistently with them.

Early in the workshop the question was raised whether conflict resolution would or could be included in the CSC's mission. It later became clear that panelists expected conflict, or its avoidance, to be the context or the object of much of the CSC's activity. But the proper role for the CSC is not to respond deftly to actual or potential conflict but to build a capability to work directly and proactively through the constellation of human values which may produce conflicts. This view is expanded below.

There was general agreement that productive discussion about specific methods such as characterization first required that the preferred orientation of the CSC be enunciated in a manner consistent with underlying assumptions about ecosystem management. Panelists suggested the CSC should be concerned with developing local sense-of-place values in an ecological context using models, tools and other devices to find harmonious relationship(s) between humans and natural communities. Put simply, the CSC should help people to develop (discover and understand their) values and to act consistently with them (and their consequent choices).

It was also agreed that there is not a single adequate measure, index, indicator or other manifestation of value(s) because, viewed collectively, they are by definition multi-dimensional and pluralistic. What is valued will vary among beholders or stakeholders but it will also vary across the landscape and with the passage of time – particularly between generations. It is suggested that multi-scalar (or multi-dimensional) notions of value should be found which accommodate different time frames, rules, and community

visions and can be used to give form to management options and to inform the act of choosing among them. Further, it is suggested that an intergenerational dialog be started between current resource stewards and those who will inherit both the consequences and responsibility for such choices. The proposed objective of developing values and the understanding and capability to act consistently is to maintain the highest possible ratio of opportunities to constraints. That is, to maximize the range of options or choices open to beneficiaries through time while minimizing the conditions that would limit such options.

Panelists disagreed about the attribution of value. Some believe that value(s) (health, integrity, or other properties) are intrinsic to natural systems while others believe that value(s) are imbued or determined by humans as they interact with natural systems. Those taking the former position believe that nature operates under some rules which transcend human decisions and that the understanding of such rules (laws, principles, etc.) is a matter of pure science. Those who take the latter position believe that health, integrity or other quality-related concepts are not self-explanatory – that they have a strong evaluative (subjective) component which should be integrated with a descriptive (natural science) component in a "community" (decision making) procedure.

Proponents of the view that values are determined by humans interacting with their environment warn against reverting to the descriptive component only which is equated with the pure science view. Their position is that the scientific dimension is necessary but not sufficient. The distinction made is partly that between the natural or physical sciences and the social sciences. This distinction is made conspicuous by the near absence of socioeconomic dimensions from ecological characterizations. Those holding the majority view in this matter remind us that socio-economic characterization methods do exist and need to be much better represented in the decision matrix with conventional ecological methods. They encourage planning characterization work to gain early experience in densely populated areas and suggest that excellence could be achieved for the CSC by structuring its work to demonstrate leadership in "dealing with humans."

Those taking the majority position on the issues above asked which is needed; a new form of work that includes socio-economic considerations or a broader name for reformed work? Specifically they asked: is ecological characterization the best term for needed capabilities or is a new term needed for a different mix of methods broadened to include socioeconomic dimensions? Many felt the distinction and the improvements and obligations it entails could only be made strongly and consistently enough by adopting a new term. Others acknowledged the need for balance but preferred rather than reinforcing the dichotomy, to join the natural and social sciences as contemporary variants, as landscape ecology, ecological economics, and some other variants already seek to do.

C. Framework for implementing ecological characterization

There was agreement that a general framework could be adopted to begin characterizing different and highly variable ecosystems but that such exercises need to produce more situation-specific methods and that a suitable process for embedding management activity in a larger "values-oriented" context should be devised and used as both a guide and a vehicle for subsequent work. Note that it is not now clear, and should therefore be learned, how best to create the necessary values-oriented process, as described above. With that caveat, other useful guidance is outlined below for operationalizing ecological characterizations.

Present process in form of a procedural model

Panelists foresaw a progression of events which would initiate and should typify the CSC's involvement with issues of ecosystem health, integrity, and management. The circumstances expected were ones in which communities of different sorts would approach the CSC for assistance. A joint response would be made to help such communities discover and articulate values which would culminate in community visions of their options or choices and associated tradeoffs. As they begin to be articulated, community values will determine what should be described in ecological characterizations. Characterization and other methods will harness tools and technologies together with training and support efforts to inform the process of moving from articulated values to management schemes that are consistent with those values.

Two things are missing that would be most helpful in progressing from values to consistent management schemes: a more universal process to guide these progressions and a unified system of values with which to compare choices and make selectioins based on their trade-offs. Both could be created by the CSC and others who can continue from the general guidance provided below. Both also raise an important question which should be explored in the CSC's characterization work: how can these and related forms of information best be integrated and delivered to users?

A goal-oriented procedure can be pioneered by a foreword-looking agency such as the CSC based on stakeholder involvement. To be successful such a process should be inclusive, it should be designed at the beginning (not on an ad-hoc basis), and it should be comprehensive, well integrated, and holistic. As a strategic consideration, such process design should begin with and should emphasize uncertainties since it is these subjects about which there is less confidence or consensus, or more contention, that lie at the heart of the problems which an agency such as the CSC can help to resolve. Similarly, we are reminded not to shrink from the complexity of these problems but instead to capture the complexity of them and their native systems. The next steps will be to refine a procedural model from these generalities to inform its details and explain how it will go beyond reforming "simple" ecosystem classification. We will need to explain how the model will

actually work, who will be involved and how, what resources will be used, and what benefits are expected.

The CSC can also lead in developing a unified system of valuation for coastal ecosystem management. This will require collaboration and vigilance in avoiding the temptation to treat ecological characterization or other science-based operations as purely objective/descriptive ones. A broader values context for work in these areas will need to be preserved. The process modeled for this purpose (above) should help to perform a values inventory for target systems, ideally using common units which are comparable. One system of common units which might be considered is that of Emergy dollars (EM$). But, we are reminded that while the EM$ scheme does capture opportunities, it is descriptive only and if used, should be merged with the values dimension to incorporate the element of choice.

Assess user needs

Ideally, once one begins to discover values held by communities of people, it is possible to begin the characterization process by assessing which user requirements will be met. But, if practicality demands that products and capability be demonstrated first, then there will need to be continuing effort to identify customers and their real needs. The assumption here is that an early convergence will be sought between products and emerging values in targeted systems.

Otter Island was discussed and accepted as a reasonable starting point to develop the capacity to conduct ecological characterizations. This acknowledges that the range of conditions and processes that will ultimately need to be characterized will be configured differently in different systems and that many will not be represented (adequately) at Otter Island (for example, it is not an area with dense human population). Given the strong base of work already completed in the adjacent Edisto River Basin, it was thought possible to take that work to a second level which could expand into the values domain. (Note that work for the Edisto River Basin which focuses on socioeconomic dimensions was not discussed at the workshop but may reinforce the above point).

Panelists emphasized that the CSC, beginning with assessment of user needs, should exploit pubic participation methods and models and that there are sufficient existing tools and knowledge to justify this. With respect to level of effort and particularly sustaining effort, as discussed earlier, it is expected that the capability of the CSC to assess user needs in target systems could be exhausted servicing other NOAA functions, if such expectations exist or arise. Caution and realism was advocated with regard to making credible, consistent commitments.

Relationships were discussed between guidance provided at this workshop and that which could be expected from the workshop following at Seabrook Island, SC. Panelists saw both bridges and boundaries between the two. The Seabrook workshop, it was felt, should

further address questions of "why" (why perform characterizations, why will they be beneficial, etc.) by beginning to identify the universe of users and their needs in a participatory forum. In particular, it was cautioned that the subsequent workshop of ecosystem managers and other practitioners should not (merely) rubber-stamp the results of the science advisory panel. It was suggested that CSC staff work with Seabrook attendees to examine expectations that would be at play in planning or executing ecological characterizations. Especially important, they warned, were more extreme expectations which could help set realistic bounds on the effort required and the outcomes to be achieved.

Consider key questions

It was suggested that the first component of needs assessment is that of identifying which questions are being asked or which should be answered, in order to meet needs. Procedures for selecting such questions were not discussed but four points of guidance were offered.

1. Effort to meet needs should be foreword-looking. As such, they should focus on developing community vision (from values), and on planning for consistent management. They should not focus on what were regarded as consequent actions such as implementation, enforcement, or feedbacks. Unless a proactive approach is taken, ecological characterization and ancillary methods will not be used early enough to anticipate or adequately influence outcomes.

2. In determining which questions will be answered with the help of ecological characterization, it is critical to orient to examination of options and (multiple) choices, rather than to providing singular solutions.

3. The utility of ecological characterizations should be broadened by addressing the over-arching theme of system integrity and tradeoffs that accompany options and choices.

4. Particularly with respect to institutional aspects, it is important to remember that the autonomy of the CSC's Analysis and Characterization component is, or should become limited, in so far as other components should come to perform complementary functions and should share influence in asking and answering questions.

Consider how decisions are made

A second aspect of needs assessment is understanding how decisions are or will be made. A point reiterated in this connection is that ecological characterization should not have as its first priority, the servicing of enforcement functions. With that caveat, two suggestions were made which would be useful in larger efforts to be cognizant of how decision processes work in a subject system. It was recommended that early in its life cycle,

characterization should include built-in involvement of managers and that such participation should be significant and direct. It was further suggested that ecological characterization should support not only managers but management as well. This distinction was made to acknowledge that designated resource managers, vested interests, and citizens at-large may have different needs. Resource manager's needs might be narrowly constrained whereas products useful to the public might need to be much more versatile in their application.

Assess data requirements

General comments

The tactical question was posed whether ecological characterization products would be more useful (than hardcopy antecedents) if delivered as published data sets with accompanying access tools in compact disk (digital) media. There was general agreement that compact disk format for delivery would be useful, perhaps in the sense that any appropriately "modern" digital format could be more useful than traditional paper copy formats. But the question that arose in response was whether compact disk publication would add value to its contents - ecological characterization. The answer, it was felt, is a function of the uses to which characterizations are put. Anticipating all such uses, while planning for specific cases may be difficult or impossible.

Related discussion focused on the opportunity to add value by incorporating data and analysis/exploration options that would not be available in a paper copy approach, not the least of which would be interactivity of the user with the product via the computer interface. Consensus seemed to be that, subject to user requirements and other "implementation" considerations, digital data publications for delivery of ecological characterizations in compact disk format would be a useful improvement.

Thematic data

Presuming that characterization methods will be underpinned by a framework for discovering and acting on "community values," three suggestions were made which are relevant to the discussion of ecological characterization. First, to better inform the evaluative aspect of characterization, one should include descriptive elements dealing with both the present and the past. This can begin to establish causes and consequences and can help create the temporal "sense-of-place" referred to above. Second, one can add value to such a descriptive approach, of which the Edisto River Basin Study is a good example, by actively including socioeconomic dimensions. And we are advised that sufficient tools and knowledge already exist to do so. Third, one should account for inputs to and outputs from the system and present these and other properties of the system in a manner that depicts dynamic change.

Temporal data

An important early consideration clearly identified at the workshop is that of designating appropriate scales, both temporal and spatial (see below). Panelists did not discuss specific means of determining the "right" scale but did discuss general guidance in doing so. Also, there was ensuing discussion, and some emphasis on the related concept of sense-of-place which most would regard as a strictly geographical concept. But sense-of-place, or something like it, was thought to be important to carry-over to the temporal dimension. Some panelists thought it valuable to try to foster understanding of a kind of "base line" vantage point for "valuers" trying to understand a system's time continuum and their position/role in it. A key concept in discussions of temporal scale was the establishment of forward-looking thresholds by which time(s) community preferences might be satisfied. For example, users might ask, hypothetically, "what should the system look or be like after passage of a certain interval of time?" This kind of question reflects directly back to discussion about values and particularly to a community's vision for the future.

Spatial data

As stated, there was cautionary discussion about the importance of getting spatial scale aspects of ecological characterizations "right" and it was emphasized that scale choice is critical to the usefulness of such products. There was acknowledgment that precedents and some guidance exist for making scale determinations and that emphasis at the workshop was needed on other strategic considerations. Specifically, it was recommended that multiple-data schemes be used where possible, to build on frequent need for different, simultaneous scales. This recognizes implicit differences among manifestations of user needs, ecological/socioeconomic problems, and systems or subsystems processes and functions. Especially important in such a multi-scale approach would be the broader scales which may be more revealing about longer-term, slower-acting changes occurring at "landscape" and other broad scales. There was also brief discussion of the problems of linking scales in such a multi-scale approach so that analysts would be able to relate in a valid manner, the information contained in data of different scales. While this question of scaling-up or scaling-down between data sets has meaning for current ecological characterization, it is also an issue for ongoing research and simple solutions are not expected to arise from work undertaken by the CSC.

Assess analytical / modeling requirements

Consistent with a concern that characterization as a set of methods should be forward-looking to achievement of management goals consistent with community values, it is also recommended that the techniques of ecological characterization should include capability to track progress toward achieving such goals. It was similarly suggested, consistent with expectations that it should be better able to represent change, that ecological

characterization should include means of showing interactions of sources or causes with responses of systems and their management regimes.

Caution was urged against reliance on or over-emphasis of any single technological approach or technique. An example used was that of relying on GIS (geographic information systems) only as an exclusive environment in which to analyze or visualize problems and solutions. One complement to GIS technology discussed is Emergy analysis which, it was suggested, could be used in concert with GIS to produce maps of Emergy dollars showing spatial patterns useful in comparing and evaluating available choices. Another complement to GIS or other technologies is mathematical or simulation modeling which can reach beyond the constraints of data themselves to help understand otherwise hidden relationships.

In this context, modeling is a special case of analysis, potentially unique because it may go beyond data analysis using numerical simulations and computer algorithms to study relationships that can further inform data analysis. As used here modeling refers to mathematical or process models not to cartographical models or other purely procedural expressions. Conceptual models may also apply. In particular, such models can be used to relate data sets or "layers" within a GIS in ways other than by simple Boolean operations. We are reminded to rely on models (both dynamic and static) to simplify the systems whose complexity we are also encouraged to capture, in order to help make them understandable and manageable. And this complexity which should be accounted for – which may be increased by the inclusion of socioeconomic factors and requires an integrated (not compartmentalized) approach to characterization and management – can also benefit from mathematical models. Very brief consideration was given to a gaming approach to modeling not unlike SimCity. Similar work mentioned is underway on a product called City Bio II.

Determine tolerable degree(s) of uncertainty

Included here for completeness, uncertainty was only a brief subject of discussion. It was recommended that an appraisal be made, *a priori*, of the decision system's tolerance for uncertainty about data, understanding of relationships, and inferences drawn.

Match answerable questions to collectible data subset(s)

This last point echoes long-accepted scientific procedure for narrowing a range of interesting questions to those that constitute a researchable problem (answerable and useful) and limiting the universe of collectible data to those actually required to answer designated questions. However, several important points were made which relate directly to which questions are answerable and which data are appropriate. First, it was recommended that characterization be undertaken for different ecosystem types for the purpose of developing comparative understanding and versatility among the methods and techniques used. This is all the more important if we are to take seriously the suggestion

that such efforts should include densely populated areas and socioeconomic methods. If such a comparative approach becomes too resource intensive, then ranges of management scenarios could be adopted as a compromise to provide a richer range of experience. Second, it was suggested that characterizations include the development of scenarios for the future. This will require, for description, that they take a foreword-looking orientation but, if we are to avoid lapsing into description-only, it will also require, for evaluation, that we devise a model/ process with which to discover values and act/manage consistently.

Identify software, models, and other tools

Identification of specific tools and techniques, software or otherwise, is the point at which discussion and recommendations from this workshop terminated. It was agreed that these choices became system and situation-specific and were therefore, the natural domain of those carrying out and publishing an ecological characterization and those who will use such work products. Further discussion of tools and techniques was also the planned point of transition to the second, follow-up workshop (Seabrook Island), focusing more directly on implementations.

APPENDIX A.

Contributed remarks: John J. Kineman and Dr. Bradley O. Parks

Ecological Characterization: a working definition

The Advisory Panel for this workshop emphasized that ecological characterizations must include human dimensions, and thus might better be regarded as "socio-ecological characterizations," to represent the combined influences of ecology, environment, management, and the full dimension of societal needs and impacts. The panel also emphasized that ecological characterization should address the need for and increasing emphasis on ecosystem-based management, which has the goal of improving ecological and socio-economic sustainability in ways that explicitly consider present and future generations. This means balancing natural factors and human values in a stable manner – a challenging task that will require better knowledge and understanding, informed valuation, and suitable management tools. As an outcome of these and other discussions at the workshop, the following expanded description of Ecological Characterization was produced, and was contributed for use in the proposed prototype effort.

Ecological characterization is a structured approach to the synthesis of current knowledge about ecosystems and human activity for management purposes. Although definitions vary, in general, ecological characterizations synthesize interdisciplinary knowledge about ecosystems including their biological resources, physical environment, key processes and important human interactions. (Note: This is distinct from another common use of the term "characterization," which refers typically to a single characteristic of the environment, such as "land surface characterization," which may be part of the data and information base for an ecological characterization). Ecological characterizations may also include descriptions or analyses of anticipated resource uses, proposed development scenarios, and management response options. We propose that the primary purpose of such characterizations is to involve users with the raw material for understanding ecosystem management.

Accordingly, an ecological characterization should incorporate at least the following three elements:

- A clear management orientation identifying the issues being considered and the overall goals served by management options, including perspectives on societal impacts and valuation. This may include the presentation of management plans and future scenarios.
- A coherent picture of the ecosystem and human interactions, including the system's constituent parts and functional ecology. This may require the use of models.

- It must incorporate and reference a comprehensive data and information base. This should include equally comprehensive metadata and documentation, along with key bibliographic data and access tools for all of the above. Owing to the technological opportunity to provide integrated databases in digital form, it is now possible to give users capabilities to directly manipulate databases for analysis, modeling, validation, and other user-defined purposes.

Digital publication provides new opportunities to organize and access ecological characterization information so that it can help meet changing management needs. Combining natural science, resource, human use, and management information in an interactive format with analytical capabilities enhances the user's capability to compare information across themes, through time, between locations, and at different scales. Employing digital technologies promises products that can be improved and reissued in a practical manner, incorporating updates and revisions as new information becomes available. This flexibility strongly supports adaptive management goals by providing tools for addressing multiple questions, for planning management strategies, and for retrospective analysis. It also provides a means to incorporate results from such exercises in future product releases.

Since ecosystem information can be extremely complex even for simple questions, it is important to limit an ecological characterization to those elements that address key system factors. We suggest that these include the following focusing influences. A characterization is necessarily limited by our present understanding of ecosystem function, which may be represented by a general conceptual model of important components and their interactions, including human factors [*Editor's note: see the example of a conceptual model provided for this workshop by H.T. Odum in Appendix D*). Second, Characterization information is focused by management goals and the nature of the questions and issues of interest. Third, a characterization is based on current knowledge - it is not a program of study. Accordingly, it begins with synthesis of available data and information, human use and management scenarios, and descriptions and models of processes, prioritized by its defining constraints. It may require field work to supplement or validate observations and may identify data and information gaps, but its clear emphasis is on practical application in the immediate future.

APPENDIX B

Contributed remarks: Dr. Fred Holland

Synthesis of (Thursday) Discussions and Recommendations for Activities CCEH Should Undertake

The comments below represent my synthesis of the brainstorming and other discussions that occurred at the Boulder workshop on March 9-10, 1995. I think all of this is in the workshop document you prepared. I am, however, concerned that the style of the document makes it difficult to pull out the synthesis portion, The document also contains lots of "buzz words" and jargon.

[*Editor's Note: An earlier draft of this synthesis was the basis for Dr. Holland's report to the second workshop at Seabrook Island, March 15-17. To avoid redundancy, only the more complete version is included here.*]

SYNTHESIS

- Watershed scale ecological and landscape analyses, historically called ecological characterizations, provide information that is useful for making coastal environmental decisions; however, they are not broadly used in the coastal decision making process. Major reasons existing ecological characterizations are not critical elements in the coastal environmental decision making process are:
    - They have not been problem driven in the context of Environmental Assessments prepared under the National Environmental Protection Act. In some sense, these documents tried to be everything to everyone rather than trying to answer a few specific problems. In a sense, I think we who prepared them prepared them thinking they were an encyclopedia.
    - They are not readily accessible by the decision making community (e.g., local land planning agencies, regulatory agencies) because they had limited distribution, were too large to be read, and contained too much extraneous information.
    - Existing characterizations were developed to be static documents; as a result most of the existing ones need to be updated.
    - Many characterizations do not contain sufficient information on socioeconomic conditions to establish linkages between anthropogenic influences and ecological condition (i.e., they do not contain all the information that decision makers need). Human values were not included in most of the documents because ecologist still do not consider human values as part of "their"

assessment process. We simply do not know how to deal with and include human values into our ecological assessments.

- Existing ecological characterizations do not generally include information to allow identification and evaluation of future risks or a range of what-if scenarios; none provide the interactive capability to evaluate new what-if scenarios. We simply do not have the simple models that can be included to accomplish this.
- The data used to develop existing ecological characterizations are not in a format that make them readily accessible to the broad range of users they try to serve.
- The data characterizations documents need to be available.

- The Edisto River Basin Ecological Characterizations is an outstanding example of the science of ecological characterizations; however, the scope of this document needs to be expanded to include social and economic information about the basin. In addition, linkages between economic products/anthrophogenic activities, social conditions and environmental quality need to be established. Information resulting from the expert committees, citizen-based task forces, and oversight group (i.e., human values of the system) also need to be integrated into the characterization probably as a vision statement for the future of the basin. This would make a nice introductory chapter. The expanded characterization of the Edisto Basin would then provide a prescription for preserving the ecological integrity of the Edisto Basin. Because the existing document was not problem driven, the ecological characterization was prepared before the anthropogenic problems that it would help solve were identified. The only problem identified in the document is to provide the information required to allow more effective natural resource planning.

- Incorporation of existing technology (e.g., interactive interfaces, modeling capabilities, and video) into the ecological characterization process is critical for communication of the wealth of information these documents contain to the array of audiences they can and should serve. This is the only way to make the data available and to conduct "what-if" analyses.

- One possible reason that ecological characterizations are not more broadly used, especially by non-technical audiences, is that their name does not adequately represent the scope of the information these documents contain. Planners, environmental managers, and decision makers frequently view ecological characterizations as scientific documents prepared by ecologists for ecologists. These documents are generally considered to lack the essential social and economic information required to make many, if not most, environmental decisions. Existing characterizations also do not include assessments and evaluations of present and future risks ("what-if" scenarios). Calling these documents by another name may better represent the scope of the information they contain (e.g., social, economic, and ecological, characterizations, environmental, risk assessments).

RECOMMENDATIONS

- Expand the scope of the Edisto River Basin Ecological Characterization to include socioeconomic data and what-if scenarios and use it as a "model" for the ecological characterization of the future. Call the new document a social, economic, and ecological characterization of the Edisto River Basin. Identify the problems(s) that have been identified for the basin by the citizens and expert committees and develop recommendations for solving them that are supported by the information and data contained in the characterization document. Data and maps in this 'new' version of the Edisto River Basin Ecological Characterization should be available in digital format (e.g., CD ROM) and should include additional detail on critical habitats and resources especially in [the] coastal region of the basin. An interactive interface should allow the user to conduct "what-if" analyses. The modified product described above would be helpful for developing a prescription for maintaining the high level of ecological integrity that exits in the Edisto Basin. A prescription for the future is what I think the objective of the Edisto River Basin Characterization should be. The modifications to the existing Edisto River Basin Ecological Characterization that are required to make it a model of what is needed in the future will require several years to complete.

- Over the short term (next 6 months) it is unlikely that the Ecological Characterization of the Edisto Basin could be modified to include the interactive interfaces, modeling capabilities, linkages between socioeconomic parameters and environmental quality, and what-if scenarios required to make it more useful for decision making. The only product that could be prepared over the short term, if one is in fact required, would be an "example" or "mock" product that contained hypothetical data where actual data was not available. The technical group meeting in Charleston should decide if such a product would be of value. I strongly believe an example characterization would be a valuable product, probably the most useful one that could be produced. I know, however, that I am in the minority on this issue.

- We just do not have much of the scientific knowledge to develop the models or conduct many of the assessments that are required to establish linkages between socioeconomic parameters and coastal environmental quality for coastal environments (Note: the Chesapeake Bay and some other large, highly perturbed estuaries of the northeast are notable exceptions). As a result, linkages and relationships between land use and socioeconomic conditions and simple measures of pollution exposure, such as sediment and/or water quality, have not been established for most coastal environments. This is especially true for macrotidal(>3-ft) estuaries of the southeastern U.S. This is a topical area where CCEH needs to seek partnerships with existing projects and programs to obtain the scientific knowledge that is required and to incorporate it into the decision making process.

- Develop an ecological characterization of a basin/watershed that has a high human population density and degree of impact on ecological conditions to contrast to the Edisto River Basin ecological characterization. (e.g., Charleston Harbor). This characterization should include socioeconomic and environmental information and have the capability to conduct interactive what-if scenarios.

- Develop a partnership with an existing project that can establish a relationship between human activities in coastal watersheds and overall ecological condition. This could be done through the competitive process or by forming a partnership with an ongoing contract. It could produce a example of the usefulness of landscape scale data to understand the relationships between humans and ecological condition. This is essential for developing the what-if scenarios and models for landscape scale information.

APPENDIX C

Contributed remarks: Dr. John Petterson

The Social Component of (Adaptive) Ecological Characterizations: Observations and Recommendations with Respect to the Center for Coastal Ecosystems Health (CCEH)

As the token anthropologist invited to this scientific advisory meeting, I suspect my observations could have been predicted. Simply stated, it is my belief that human values and behaviors have given rise to the problems we now confront in managing the planet's resources. And that the ultimate objective of our study and information gathering efforts is to modify these human behaviors in order to ensure the continued viability of existing ecosystem for the future inhabitants of our planet. This resource allocation process must inevitably result in conflicts in values. it seems to me, therefore, that the issue before us all is how best to address the inevitable conflicts in values that arise whenever a resource allocation decision is to be made. I hope the following comments and recommendations prove of value to NOAA, CCEH, and the wider scientific community.

The breath of expertise present at this meeting reflects both the disciplinary complexity of the issues, the global scope of the problems, and their temporal boundaries. The problems transcend our nation and our generation. Solutions to these problems will necessarily cross disciplinary, social, political, economic, and agency boundaries and historical mandates.

In overview, our role here is to advise government and the public how best to address the conflict between: (1) present values (existing use and production); and (2) future values (sustainability, viability, conservation, etc.). We hope to achieve these objectives by: (1) assisting in the evaluation the risks to ecosystems and/or individual species; and (2) assisting in the development of management approaches which more effectively address the problems currently recognized as critical.

Historical failure of administering agencies to consider human communities as important elements of the ecosystem.

Observations and Recommendations for the Scientific Community:

Observation:

(1) All of the management options and considerations before the panel of scientific experts are reflections of "social valuations" being placed on the importance of particular aspects of "ecosystems." That is, there are no *inherent* benefits to

sustaining any particular species, to "sustainable use" practices, to "multiple-use", objectives, to "threatened and endangered species" protective measures, to "retention of biodiversity", "landscape ecology", or any other set of concerns except in relation to the values attached to these characteristics by groups of people. The underlying problem is simply a conflict between values--and, therefore, the people or groups that hold them.

(2) Human values define the desired future state (i.e., policy objectives) as enunciated by the President, Congress, and State and local governments.

(3) Similarly, it is the human values (and cultural histories) of the various agencies (often very different from each other) that determine which policies are to be implemented, how they are to be implemented, and the priorities of that implementation.

(4) It is the human values (and associated behaviors) of those human populations whose actions are being limited (land owners, foresters, fishermen, farmers, industry, environmentalists, etc.) that is <u>really</u> being managed--and which can, and often do, prove most intractable.

(5) It is also these same human values that result in opposition to agency management decisions in the form of obstruction or litigation, that inhibits and/or effectively halts implementation (or, at least, the effectiveness) of resource management decisions. It has been argued that the principal cause of these legal roadblocks (and "jeopardy opinions") has been the inability of regulatory agencies to produce plans (EISs, EIR, meet imposed schedules, etc.) that satisfy the requirements of the National Environmental Policy Act of 1969, the Endangered Species Act of 1979, the Federal Land Policy Management Act, the National Forest Management Act of 1976, Coastal Zone Management requirements, and other major federal policies. All of these policies and actions, and social responses, are social factors that must be understood if regulatory policy is to have its desired effect.

(6) And, finally, *it is these values which are least understood or accommodated in the process of policy design, formalization, and implementation.*

<u>Recommendations:</u>

(1) For any particular environmental policy to be effective, all of the values noted above need to be understood, considered, and addressed. Given the critical role of these social values in determining the outcome (positive or negative) of any resource management decision, it is imperative that equal care to given to collecting pertinent social information, assembling it in a usable and balanced manner, and evaluating the merit and/or implications of the values held by all participants--those most directly affected by the action.

(2) Social information must not be considered "soft" or inherently intractable to analysis. An increasing number of social values have been found to be spatially distributed in relation to particular natural resources (and resource use patterns certainly are). Recent advances in GIS now enable analysts with familiarity and experience in the use of demographic/geographic analysis, and in portraying the distribution of pertinent values, to analyze, present, store, and distribute digital representations of social information. (We have, for example, developed GIS analytic techniques to show the spatial distribution of community values and attitudes regarding a nuclear waste repository, to map survey data, to analyze the interrelationships between demographic/economic layers and tax assessor data, or orthophotography and crime zones, lead poisoning/parcel data/and age, emergency response planning, cancer incidence and hazardous facilities/Superfund sites, etc). The utility of this technology and analytic approach is enormous and will result in a geometric increase in our understanding of these interrelationships. Many social values can, indeed, be digitized. It should be emphasized, however, that many social issues, factors, variables, etc., are not yet amenable to digitization (e.g., as a data layer), many social variables may not have geographic or spatial distribution, particular some of the more important political and social perceptions, but are nevertheless critical to understanding or predicting human response and public acceptability.

(3) There appears to be a tacit acknowledgment that "ecosystems" <u>can</u> be managed at the sizes, shapes, and dimensions debated by the panel. I do not believe this is true. Regardless, if such management is to be attempted, managers will need to increase the level of detail at which their analysis is performed. They will need much finer grained analysis of information as it pertains to resource use patterns, consumption patterns, adjacent land uses, historical, current, and projected future use patterns (e.g., trend analyses of population growth, resource use trajectories, overlain on similar data for historical ecological data bases, designed to actually track/monitor changes) and the existing social values that must to be controlled or modified to achieve the desired objectives.

Observations and Recommendations for the NOAA:

<u>Observations:</u>

(1) NOAA is located in a peculiar political geography--somewhere between Congress and the public, precariously situated in relationship to a wide variety of overlapping and, sometimes, competing federal agencies and other jurisdictions.

(2) Existing institutional structures appear, increasingly, to impede or prevent the resolution of value conflicts. Increased interagency cooperation, a clearer breakdown of organizational mandates and lines of responsibility, and clearer representation of these lines to the public, would dramatically improve the effectiveness and perceived integrity of the process and agencies involved. Public participation, true and

effective public participation (in the sense of genuine collaborative decision making) will be with citizens are an essential part in moving toward trustworthy institutions.

Recommendations:

(1) In attempting to collect information or understanding in order to address a particular problem or issue, NOAA goals and objectives need to be very clearly stated -- up front. Without a clear understanding of agency missions, mandates, goals, objectives, etc., information obtained from participants will be clouded by the uncertainty or confusion regarding what the agency is "after" and how NOAA objectives pertain to their concerns or interests.

(2) In order to effectively carry out its mission, NOAA managers will need to recognize that, just like a change from one ecosystem to another, each change of issue, political setting, or geographic location will give rise to an entirely new set of affected human populations. They may look the same, that may appear to group in common patterns (environmentalists, foresters, fishermen, etc.) but the reality is that the values held by these groups will differ in important ways from previous groupings. The interrelationships between the participants, the mix of individual orientations (ethnic, social, economic, etc.) will have changed, and must be understood if public acceptance is to be achieved.

Where these differences turn out to be significant, or the positions held by the different organizations differ from their national or regional counterparts, additional effort needs to be committed to understanding the meaning and importance of these differences.

(3) NOAA and other agency representatives must be increasingly concerned and attentive to the process by which decisions are made and acted upon. Even a "perfect" resource allocation decision will be met with opposition if the subjects do not understand the underlying rationale, objective, or goal. The common reason for this is a failure to involve the affected or "attentive" publics in the decision making process itself. There are, in turn, effective ways of legitimately embracing such participation, and ineffective, counterproductive, ways of doing so. The key, again, is a clear and complete understanding of the "lay of the land" on the particular issue and particular setting.

Into the Charleston Workshop:

(1) One of the central themes of our discussions has been "how to manage ecosystems". Characterization is envisioned as an essential initial step in this process. What is meant by the term "characterization"? Do we see this process as: (a) a description of current conditions as in base case or current conditions; or (b) as the set of baseline or trend lines for all the variables? If "B", over what period of time? How are boundaries of the "system" determined? For example, do we employ drainages, as

in the case of the forest service, or do we consider all pertinent boundaries independently in relation to their own natural boundaries as they affect the particular system under study (e.g., atmospheric, terrestrial, groundwater, human habitation or activities, etc.)?

(2) Any "comprehensive" ecological characterization must include consideration of the entire range of human-induced effects on the ecological system under examination. The initial critical question to be addressed for the social assessment is "how are the boundaries of the system to be defined?" Present/past users only, anticipated future users, specially entitled populations (e.g., tribes, adjacent land owners, historic dependents), or the larger range of "attentive publics" (e.g., local/regional environmental groups, political interests, agency interests), or the larger national interests.

(3) Much of the discussion of our group appears to assume that we already know what it is we are looking for, i.e., in which domains the impacts or changes are expected to occur, and have therefore predetermined the analytic emphasis and results.

(4) Ecosystems, regardless of how they are defined, must be viewed in context of accelerated change in the dominant variable--i.e., the social, political, economic, technological, and other factors that have altered the larger environmental context of every ecosystem or subsystem). Change is not occurring in a linear fashion and, therefore, concern should be on thresholds at which irreversible consequences are initiated. Studies must also consider the trajectory of that change into the future.

(5) An underlying current in many of the prevailing approaches is that ecosystems are somehow "naturally self sustaining" (e.g., viability discussions) if protected at present levels -- e.g., assuming that remaining forests are left intact, that pollution sources are eliminated, and so on. This argument may not hold. For some species and systems, a threshold may already have been crossed and, regardless of what is done to protect them, their continued degradation is inevitable. Each of the components of a particular ecosystem have both interdependencies with other components and their own individual characteristics and processes. Where and how these independent trajectories interact/intersect with the interdependencies of other species is a complex calculus. It now seems certain, and important to acknowledge that, as unattractive as it may seem, some species have already fallen below a critical threshold and that ongoing, now unalterable, environmental changes will preclude their survival in certain geographic/ecologic areas.

(6) "Functional relationships" is a key concept that should be emphasized in the CCEH characterization effort. It is these relationships between and among the variables, particularly the human values, historic and likely future behaviors, and beliefs that will determine whether or not a contemplated regulatory action will bear the desired results.

APPENDIX D

Contributed remarks: Dr. Howard T. Odum

Defining Health of Ecosystems:

Self organization of ecosystems and their interfaces with the economy and geomorphology tends to self-select patterns that maximize performance. This can be measured with indices such as empower (Power expressed in units of one kind of energy). A healthy ecosystem has self organized so as to achieve a high percentage of what is possible with its inputs. Either mature, high diversity, old growth, successional, pioneer, restorative or net yielding ecosystems can be healthy in this sense. An unhealthy one has less than its self organizational potential for the same stage in cycles of growth and restoration.

Procedure to Improve Analytic and Characterization Work

1. First define a window of attention in space and time to be analyzed and to have GIS polygons within. Example Edisto River and coastal area.
2. Make a network diagram of the system thus defined to include ALL main influences including human users and economic interactions. See example.
3. Simulate an aggregated version of this model.
4. Examine the spatial distribution of storage's and processes using GIS methods. In addition to traditional ecologic indices, include in GIS the measures of the human economic activity per year (such as income per area, population per area, electric power use per area, waste release per area), etc.
5. [Create] a spatial simulation of a simplified unit model for various polygons representing main zones of the area.
6. Evaluate EMERGY and Emdollars so as to combine environmental and human-economic parts affecting the window using EMERGY and Emdollars, making maps of EMERGY storage, empower (EMERGY flow per time). Consider these as a way to determine what contributes more to combined economy of humanity and nature.
7. To calculate transformity for each polygon (EMERGY flow per unit energy). GIS maps of transformity should bring out a spatial pattern of converging inputs towards center of hierarchy (with centers at river mouths, at beach interfaces, at dense human settlements, etc.).
8. Examine the future alternatives using scenarios in the aggregate and in GIS display. Make tables of Em$ change for each alternative considered.

9. Study particular uses and management initiatives by considering their roles and alternatives in relation to the overall budgets of Em$ and other measures of performance.

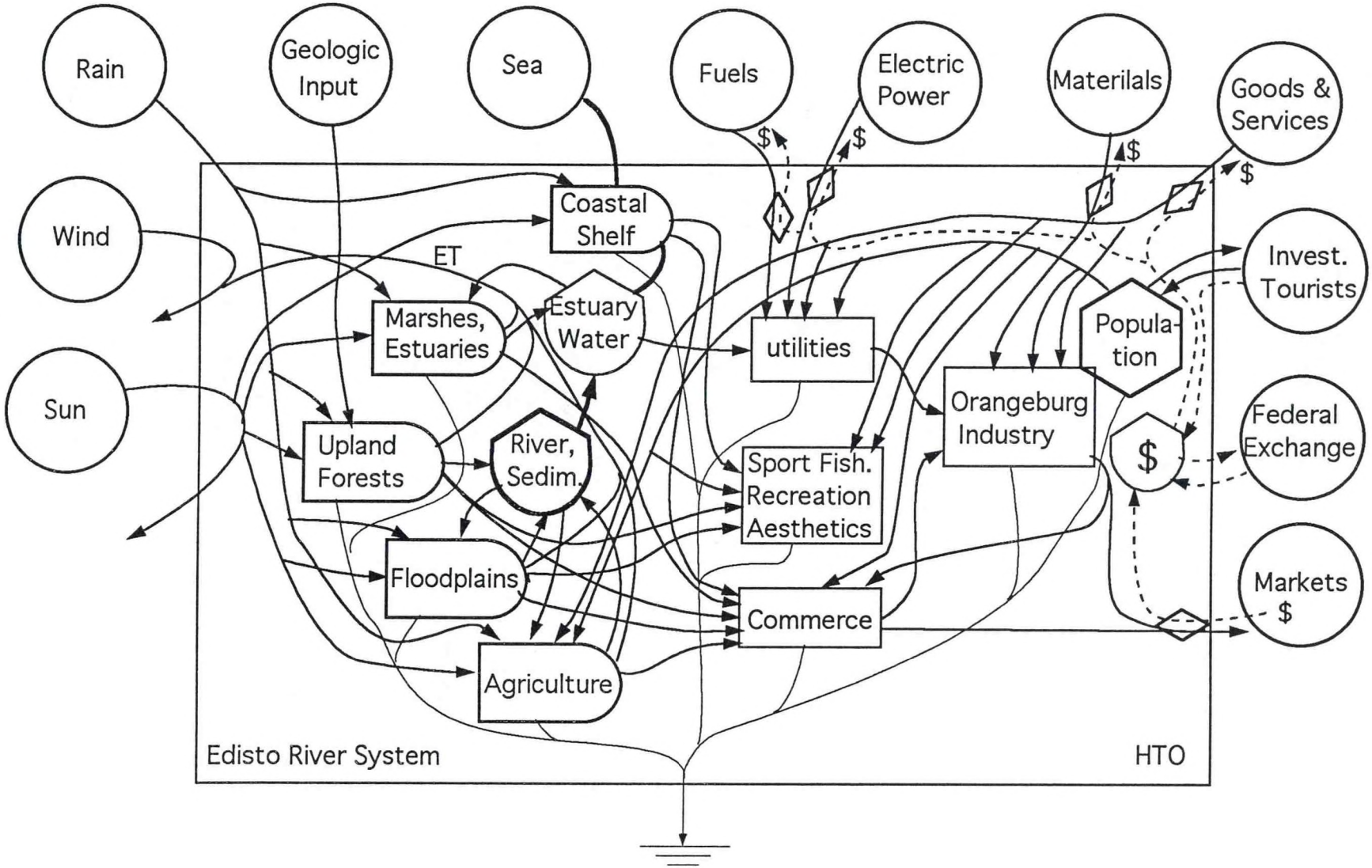
Suggestions for Connecting Ecosystem Information with Users of Coastal Environment and Policy Level Decisions:

To include the human economy and ecological management, a larger scale of study and evaluation needs to be defined. A systems diagram is helpful in showing the parts and the outside influences. When the scale of emphasis is increased to include the socio-economic parts of the coastal system, the items of smaller scale need to be aggregated. It is sometimes easier to start on the large scale and disaggregate as one goes down scale. In other words policy. In other words when power plants, towns, and commerce are included, details on phytoplankton, wildfire, and water need to be aggregated.

In order to avoid the error of using market dollars for evaluating environmental inputs and alternatives, both the economy and the environmental contributions need to be evaluated in the same units. One way of doing this is with Emdollars. (Emdollars are the proportion of the gross economic product which depends on a resource. Emdollars are obtained by evaluating the EMERGY production and use per year and dividing by the EMERGY/$ ratio for the state economy). The procedure is easy if a table of Transformities is assembled first. (Transformity is the EMERGY per unit. Flows and storages in usual units are multiplied by tranformities to obtain EMERGY storages or EMERGY flows)

Evaluations can be made in the aggregate for a whole watershed, region, or county. Evaluations can also be made in more detail using GIS. GIS data may include maps of transformity, EMERGY, and Em$ as well as other properties of environment and economy. The recent dissertation by Carol Boggess: Biogeoeconomics of Phosphorus in the Kissimmee watershed started with 7000 polygons on ARCINFO which were aggregated into maps for spatial EMERGY-Em$ evaluation.

Since EMERGY and Em$ evaluates all the useful production on a common basis, good policy and best choices may be identified by selecting alternatives with maximum EM$ production and use.


Rain
Geologic Input
Sea
Fuels
Electric Power
Materilals
Goods & Services
Wind
Sun
Coastal Shelf
ET
Marshes, Estuaries
Estuary Water
utilities
Population
Invest. Tourists
Orangeburg Industry
Upland Forests
River, Sedim.
Sport Fish. Recreation Aesthetics
$
Federal Exchange
Floodplains
Commerce
Markets $
Agriculture
Edisto River System
HTO

APPENDIX E

RESPONSES TO THE FIRST DRAFT

[*Editor's Note: Comments of a purely editorial nature were accommodated in the earlier portion of this report and are thus not included below.*]

RESPONSE #1:

- Carefully distinguish between the product and the process; I don't believe they can be totally synonymous. The product may be a report that describes the process.
- *(RE: Characterization as a long-term process)* Management, aided by an iterative, dynamic characterization, is the long-term process.
- A long-range objective of the Center must be to help people develop ecologically-related values and act consistently with them.
- "Prototype work beginning in the Edisto River Basin.." makes no sense unless we know what kind of prototype work is going on in relation to the established body of data that already exists.
- *(RE: There is not agreement about how to define or evaluate ecosystem health...)* This was an important point made during the meeting that deserves a higher profile than being buried in the middle of this list of bullets.
- *(RE: The majority view is that values are determined by interaction of humans with their natural environments...)* I believe that what we must avoid reverting to is models that exclude human factors and human interactions. These may still be descriptive models, but include humans in the description.
- *(RE: use of the word "microcosm" in reference to prototype efforts in the Edisto Basin area)* The Edisto River Basin is hardly a microcosm; in fact, the ecosystem management framework desired by the CCEH will not operate at the scale where any unit could be so characterized.
- *(RE: Section on "Ecological characterization as a process, General Comments)* I liked this section, but wonder about the sentence on doing the right thing versus the thing right. Is "the right thing" managing ecosystems, or is it rather, devising protocols (the concrete form of your "process") that use a particular tool (the ecological or ecosystem characterization) to manage from an ecosystem perspective? I strongly discourage the conceit that we can manage ecosystems.

A general comment that applies to the summary of the meeting and the meeting itself is that both suffer somewhat from a high "fog" factor engendered by a lot of "socio-speak." I may oversimplify things a good deal, but it seems that the ecological characterization

process requires a community of managers, users, and inhabitants to address (with CCEH's help) the following questions:

- What do we have (in terms of ecological resources and ecosystem functions, including humans and human influences)?
- What are the trends over time of what we have? (Directions and magnitudes of change in human, animal, plant, and chemical and physical components and their spatial relationships in the landscape.)
- What do we want? (Vision, necessarily incorporating human values)

The characterization (whatever it is, a process, a product such as an expert system, or both) then guides us to fill in gaps in our knowledge of what's there, and what the trends are, and enables us through its predictive capabilities to compare impacts of future changes (human and "natural" combined to our vision, and plan to reach the vision.

This simplification may misstate: my point is an abstracted simplification or synthesis of some kind is needed. More succinct, concrete statements of what the Analysis and Characterization section of CCEH is going to do are also needed in an abstract or summary.

RESPONSE #2:

(1) Obviously, much thought has gone into the preparation of this document! Clearly, much work was put into the assembly of a diverse array of components covering fairly sizable, spatial, and temporal scales. For this, the committee should be highly commended (since I was not present, it is not self serving to make such a remark)!
(2) Several times I tried to associate various compartments and/or fragments unsuccessfully. This is going to be a big communications problem when you start interacting with people who are less likely to share a very substantial common information base.
(3) I suggest that the theme of sustainable use of the planet might be a way of relating the disparate components in a way understandable to non ecologists. Perhaps it might even be tolerable to use the words sustainable development if you define development as ecologically non-damaging.
(4) Along these lines of sustainable use, I would make a list of ecosystem services (those ecosystem functions deemed useful by human society), and define ecosystem health in terms of continuing delivery of those services. There are some obvious dangers in this of which arguably the most important is the possibility that ecosystems will be treated as service units, but even then, they might get more respect than they now do from many elements of society.
(5) In about six or eight articles, some published, some in press, I have argued that human society is dependent on both a technological life support system and an ecological life support system, the latter being endangered by the former. The value

system might be better communicated if the consequences of ecologically unsound behavior are communicated as threats to human societies life support system.

(6) In the Abel Wolman Distinguished Lecture for the National Academy of Sciences, I argued that human society and natural systems are co-evolving since definitions by Raven and others include levels of organization higher than single species. Further, I postulated two types of co-evolution: hostile, in which the species unable to tolerate human societies present practices would be eliminated, and the ones that are essentially uncontrollable by human society would be left. In the benign co-evolution, human society changed its behavior to permit natural systems to retain their integrity. I had some misgivings with this approach, for reasons that I am certain will be obvious to ecologists. It is, in a sense, the same problem one has with defining ecosystem health. Nevertheless, I found it a useful way to open discussions with corporate executives on the problem of sustainability.

(7) I suggest that either a sequential protocol for organizing the values listed in the preliminary document in an interactive fashion would be possible, or a multi-dimensional matrix model might serve if it does not get too elaborate. Perhaps a major model with sub-models would be the way to communicate this best.

...The bottom line seems to be that all the components are present, but a synthesis linking the various components and showing how they may interact "centergistically" [sic], both positively and ...negatively, (in terms of human society), is lacking. I have, at present, no idea how this should be done. The National Academy Press book, Restoring Aquatic Ecosystems (1992), used a simple matrix with human values on one axis and ecological values on the other, to show how simple balances might be achieved that would be satisfactory to both "view points." However, something much more elaborate is necessary for site-specific use, as I found when dealing with water transfer problems in Colorado several summers ago.

RESPONSE #3

[Reviewer #4] copied me the memo he sent to you, dated 7/25/95. I concur fully with what [Reviewer #4] said in his memo.

RESPONSE #4

1) My opinions have not changed a bit since March. Therefore it would not be appropriate for me to offer detailed comments on the draft because, as you know, I believe the whole thing is off track. [*Editor's note: This comment referred to the program of the new NOAA Center in general, including the Analysis and Characterization proposal*]
2) In short, I believe that the current approach is misdirected and that the program you espouse is irrelevant to the current conservation and development needs of the US coastal zone. My opinions on the subject should be well embedded in you meeting records. [*Editor's note: since this was a minority view and out of necessity the report tends toward reporting consensus, these views may not be fully represented. Unfortunately, no further clarification was provided*]
3) Nowhere in the report do you address the real issues facing coastal management. So how can you expect to be relevant? [*Editor's note: this is taken to be a criticism of the focus on methods rather than the issues themselves*].

RESPONSE #5

I am still uncomfortable with the phrase "ecological characterization" even with the caveats regarding values. I'm just very sensitive to our tendency to revert to "pure science." But I admit I can't come up with another brief phrase. What we want to say is something like an "ecologically and value .....[unreadable]. Try playing with the "opportunities/constraints idea which has the advantage of incorporating both physical features and limits and value-reactions to them. How about "ecological opportunities inventory?" Otherwise, a good job.

RESPONSE #6

I have no objections to the draft, but it is so dense with observations that it would be useful to have a short summary at the beginning of the major recommendations. [*Editor's note: an Executive Summary, as well as other introductory sections were added after the review.*]

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